

Shutter artifacts

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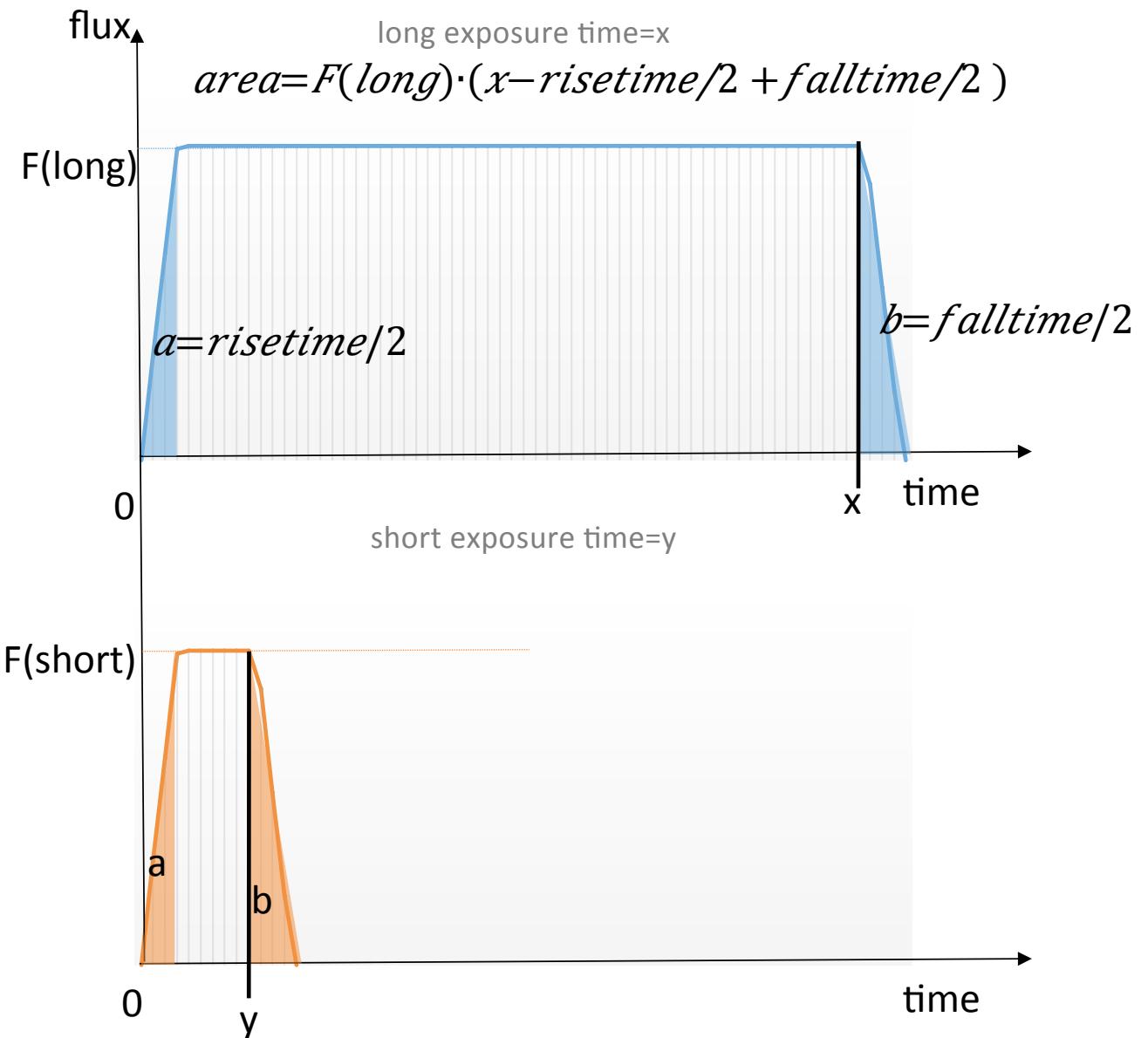
Idea

- If shaded area are negligible, total flux collected should be proportional to the exposure time.

$$ratio = x - a + b / y - a + b \approx x/y$$

$$ratio = x + c / x / y * (y + c) = x + c / x + x / y * c \approx 1$$

$$(c = b - a)$$

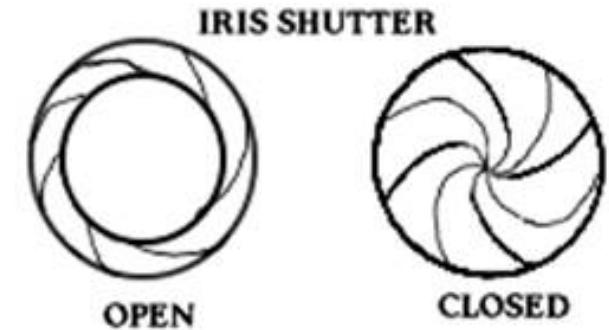


Ratio of long exposure and short exposure

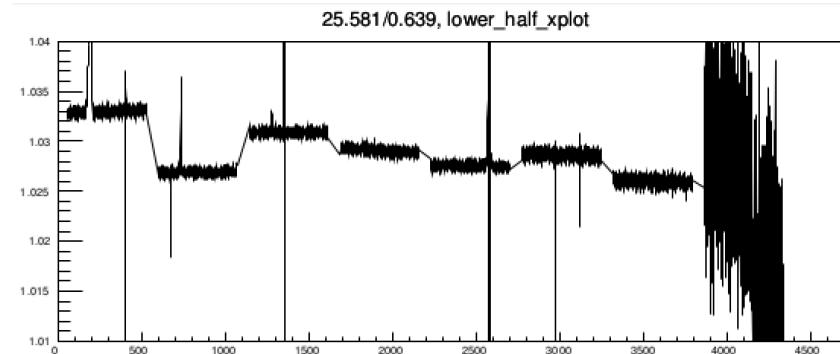
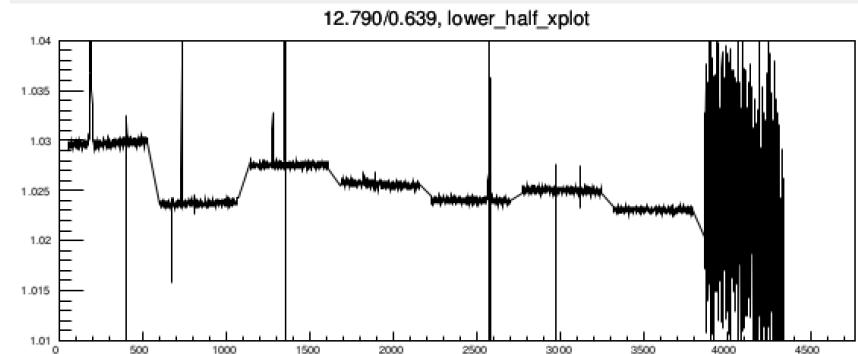
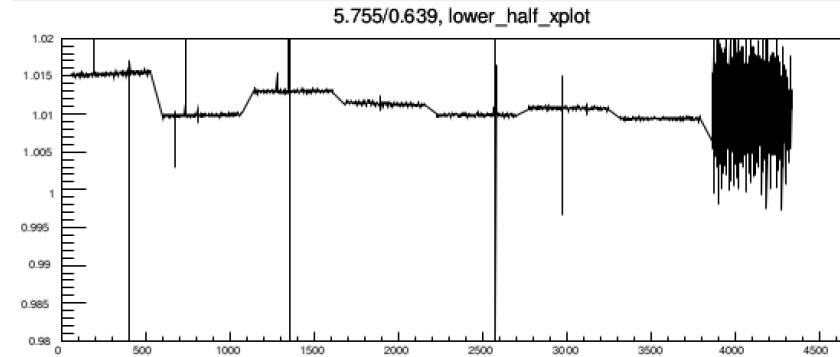
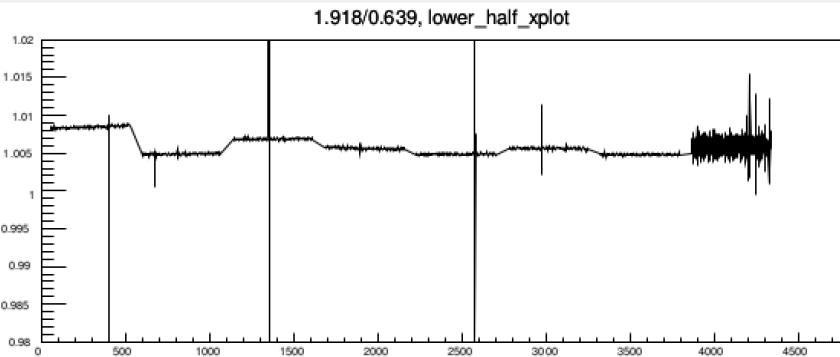
$$\begin{aligned} & \text{flux}(\text{long}) - \langle \text{bias} \rangle / \text{exptime}(\text{long}) / \text{exptime}(\text{short}) \\ & \times (\langle \text{flux}(\text{short}) \rangle - \langle \text{bias} \rangle) \end{aligned}$$

- Long exp. times : 1.918, 5.755, 12.790, 25.581 sec
- Short exp. time : 0.019, 0.038, 0.058, 0.116, 0.251, 0.387, 0.503, 0.639sec

Lower half for exp. time 0.639 sec
we don't see any shutter spatial
artefacts

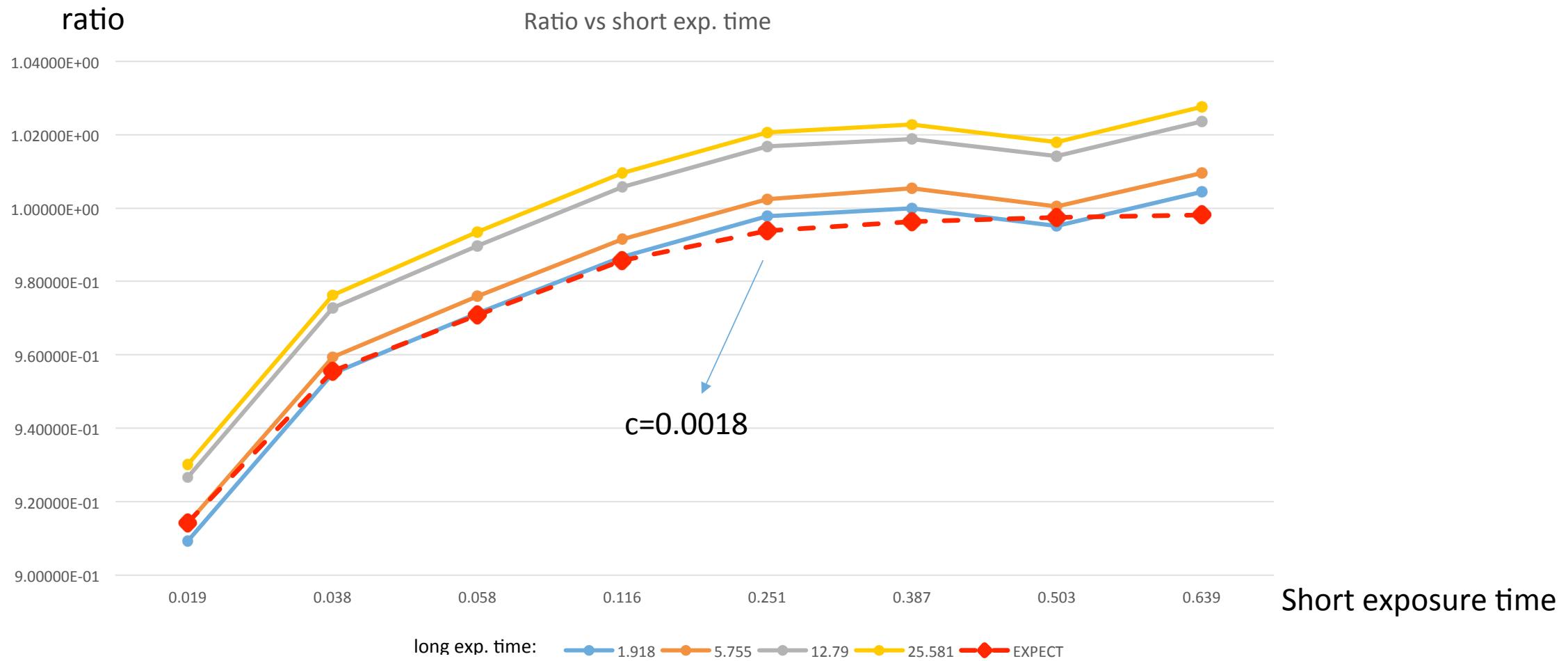


Ratio



Ratio vs exp. Time for short exposures to study open/close effects

$$ratio = x + c / x + x/y \cdot c \approx 1$$



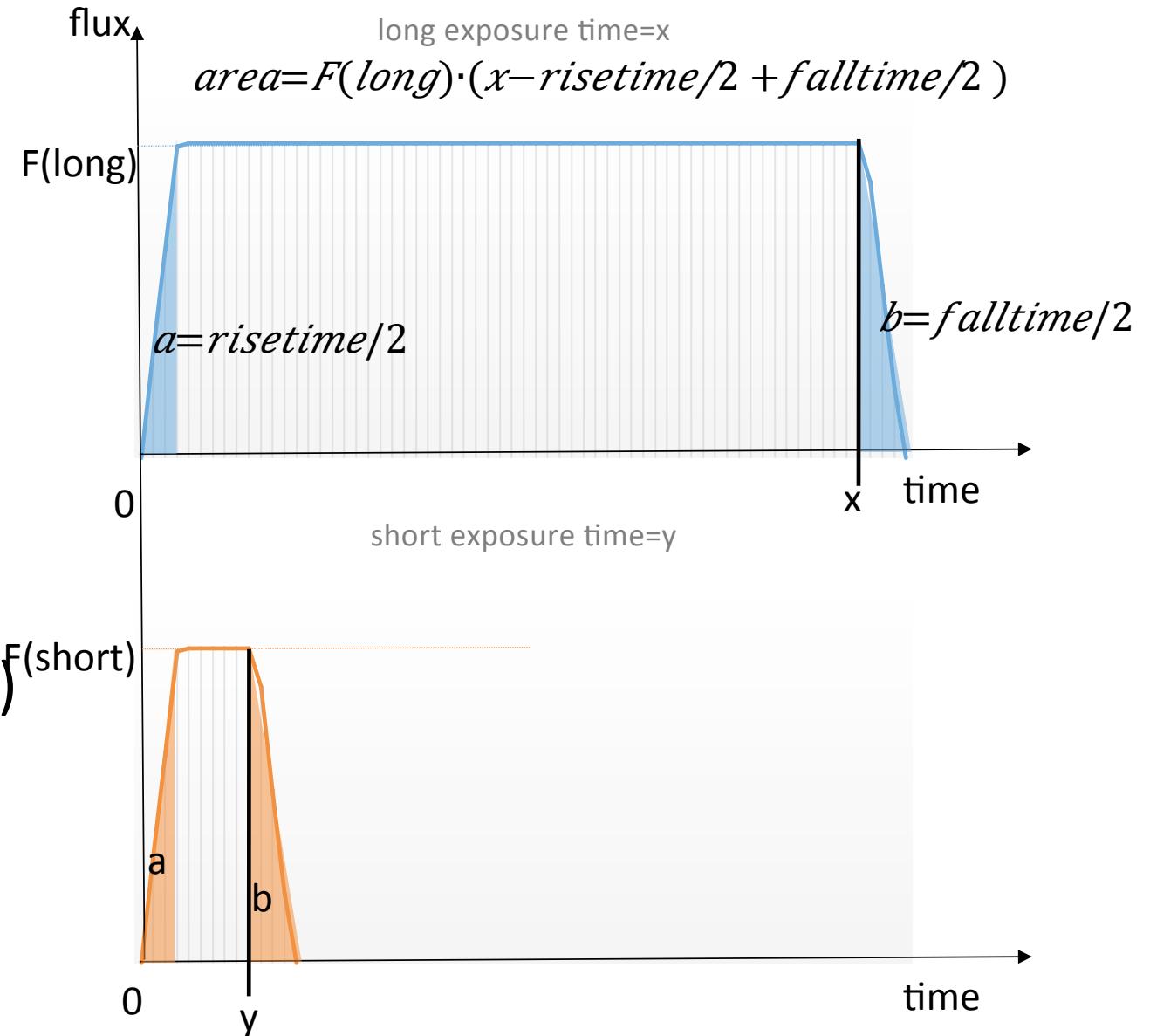
What's missed

- If you want to calculate ratio like this:

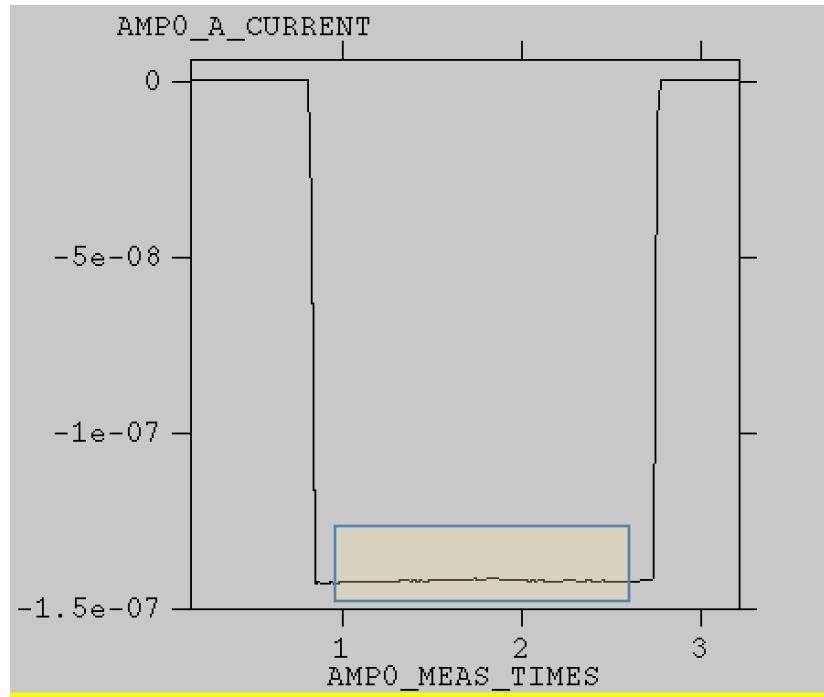
$$ratio = x + c / x / y * (y + c) = x + c / x + x / y * c \approx 1$$

$$(c = b - a)$$

you need to divide $F(\text{long}, \text{short})$ from $\text{area}(\text{long}, \text{short})$



MONDIODE correction

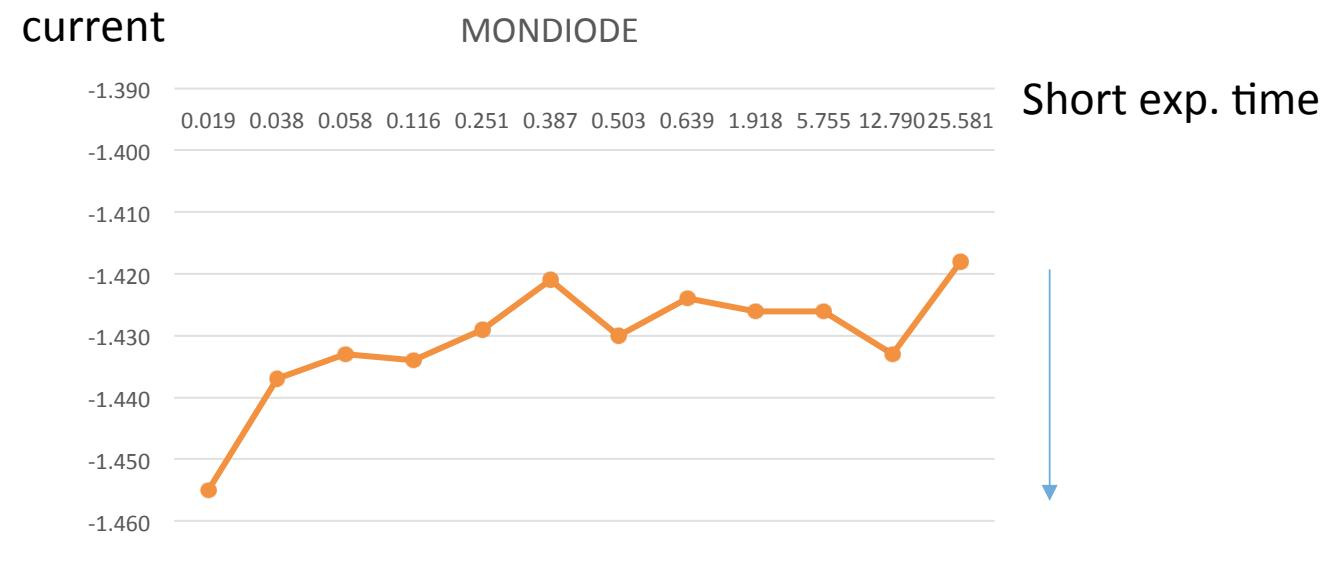


7.33E-01	3.20E-10
7.51E-01	2.62E-10
7.70E-01	2.62E-10
7.87E-01	2.04E-10
8.05E-01	2.04E-10
8.23E-01	-6.59E-08
8.41E-01	-1.43E-07
8.58E-01	-1.44E-07
8.77E-01	-1.43E-07
8.95E-01	-1.43E-07
9.12E-01	-1.42E-07
9.30E-01	-1.42E-07
9.48E-01	-1.42E-07
9.66E-01	-1.43E-07
9.83E-01	-1.43E-07
1.00E+00	-1.43E-07
1.02E+00	-1.43E-07
1.04E+00	-1.43E-07
1.06E+00	-1.43E-07
1.07E+00	-1.43E-07
1.09E+00	-1.42E-07
1.11E+00	-1.43E-07
1.13E+00	-1.43E-07
1.14E+00	-1.42E-07
1.16E+00	-1.43E-07
1.18E+00	-1.43E-07

- MONDIODE value on header are not appropriate for the correction since it also integrates current values while opening and closing shutter, so I chose the area highlighted to average and used that value for the correction.

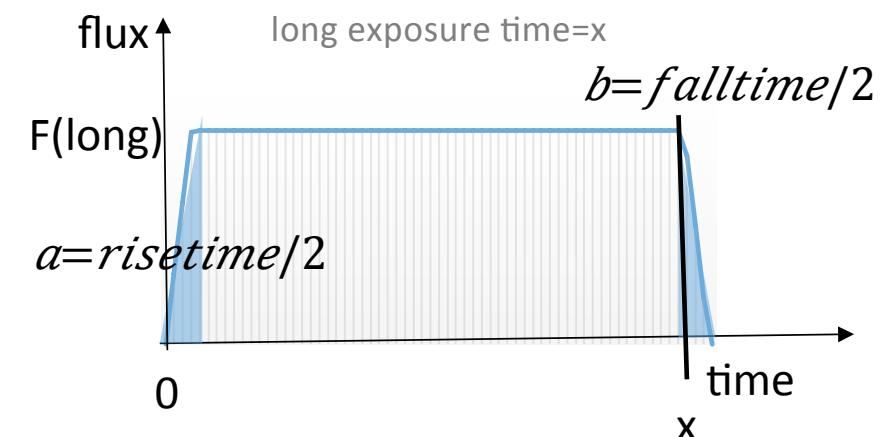
MONDIODE correction

Exp.time(sec)	current	MONIDIODE (header value)
0.019	-1.455	-154.781
0.038	-1.437	-148.056
0.058	-1.433	-146.278
0.116	-1.434	-144.905
0.251	-1.429	-143.573
0.387	-1.421	-143.245
0.503	-1.430	-143.386
0.639	-1.424	-143.370
1.918	-1.426	-142.793
5.755	-1.426	-142.502
12.790	-1.433	-143.287
25.581	-1.418	-142.262



$$area = total\ flux = F(long) \cdot (x - risetime/2 + falltime/2)$$

To calculate the ratio $x-a+b/y-a+b \approx x/y$, we need to divide total flux by $F(long)$ or $F(short)$ and the ratio $F(short)/F(long)$ is same as $I(short)/I(long)$

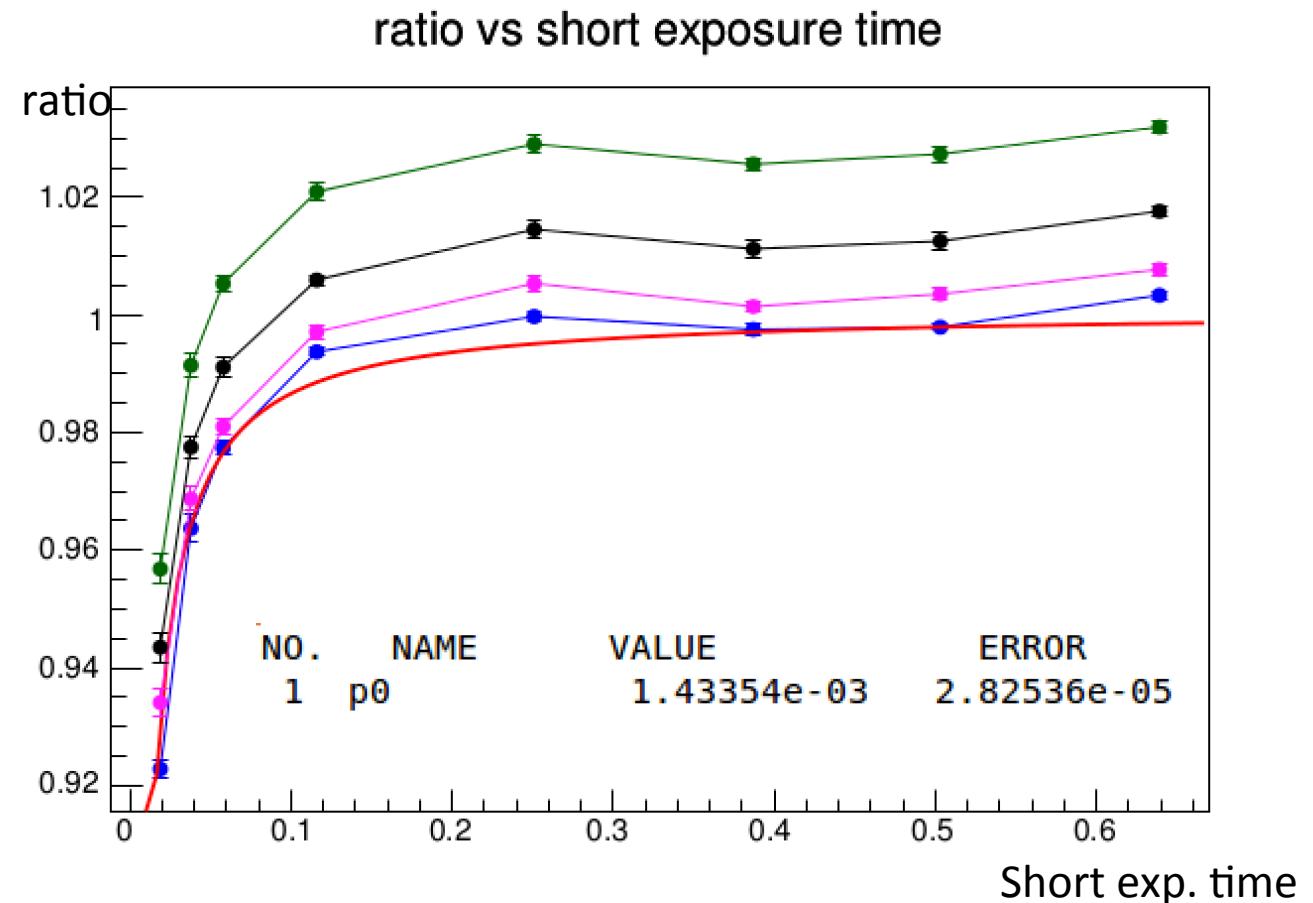


Ratio vs exp. time with Mondiode correction

Measured ratio= $(\text{flux}(\text{long}) - \langle \text{bias} \rangle) * I(\text{short}) / I(\text{long}) / \text{exptime}(\text{long}) / \text{exptime}(\text{short}) * (\langle \text{flux}(\text{short}) \rangle - \langle \text{bias} \rangle)$

expected ratio= $x + c / (y + c) * x / y$

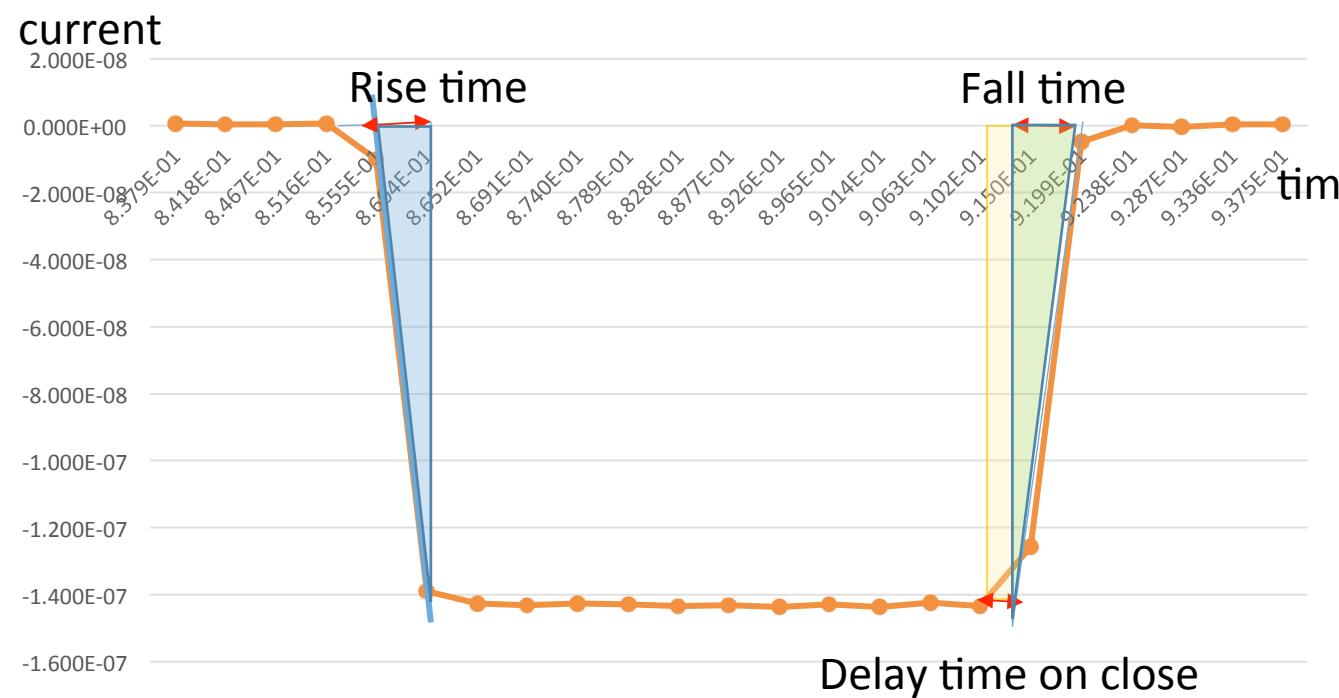
c=b-a=time(fall)-time(rise)/2



Compare with specs

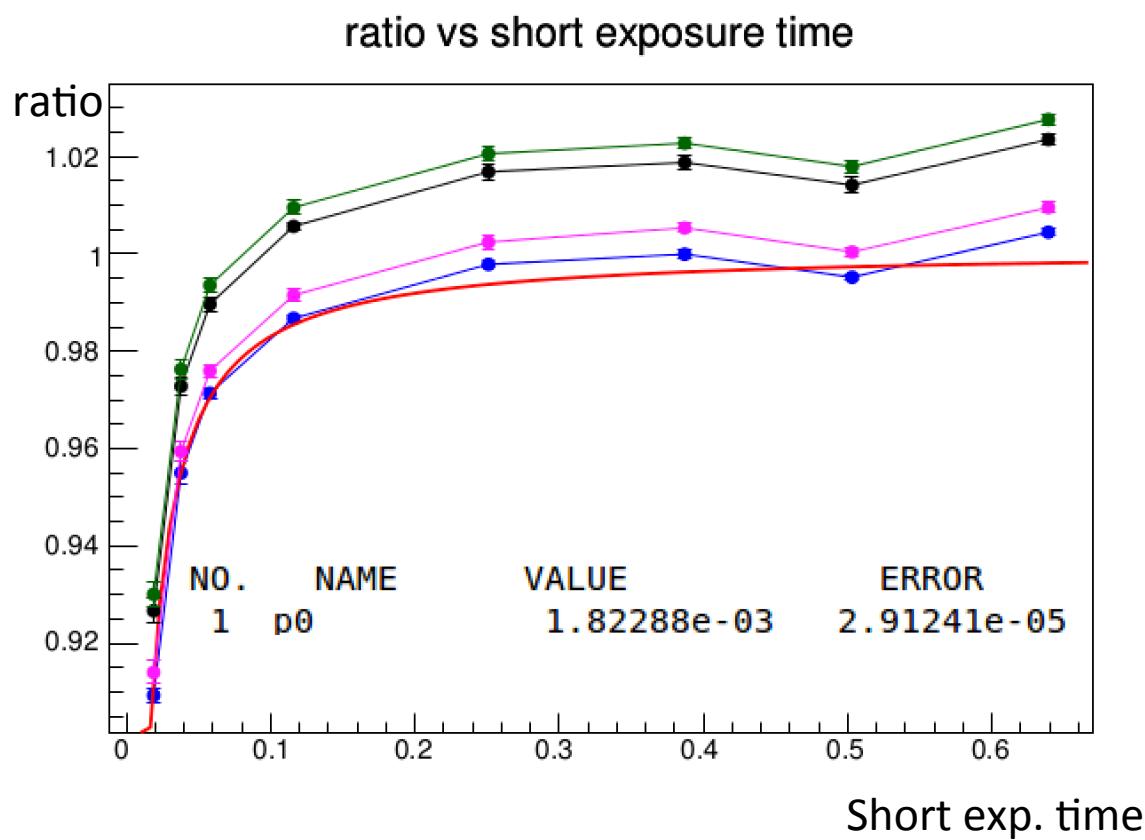
- 1) Constant $c \sim 0.0013$ according to spec.
- 2) Actual rise and fall time on open and close was $\sim 4.1\text{ms}$ and 5.9ms and delay time to close was $\sim 0.4\text{ms}$. so $c \sim 0.0013$
- 3) Best matching for expected line and actual lines has $c \sim 0.0014$

	A, risetime(ms)	B, falltime(ms)	C = (B-A)/2 [ms]
specification	3.9	6.5	1.3
Current plot	4.1	5.9+0.4(delay)	~ 1.3
CCD measure			~ 1.4

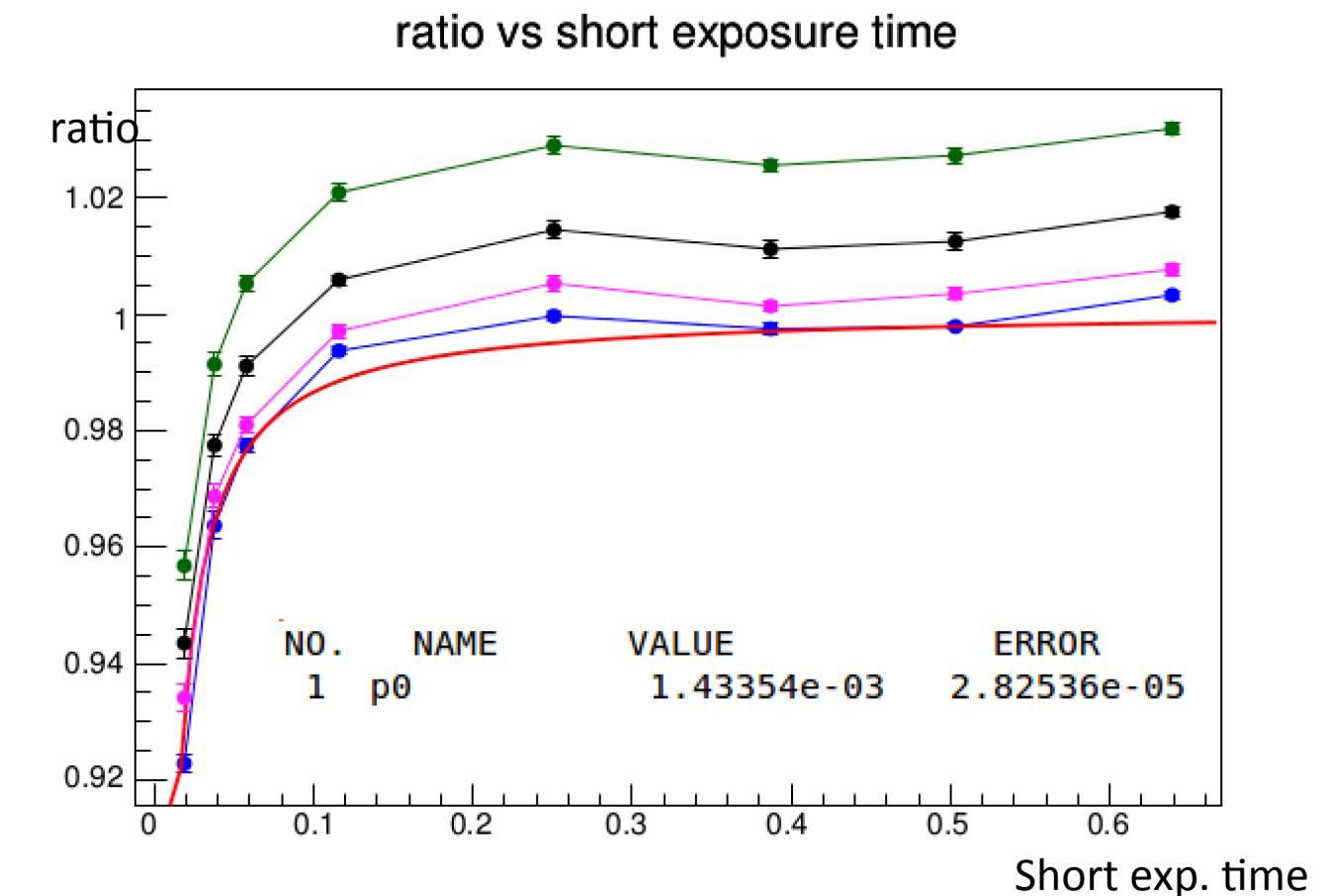


Compare with plot before mondiode correction

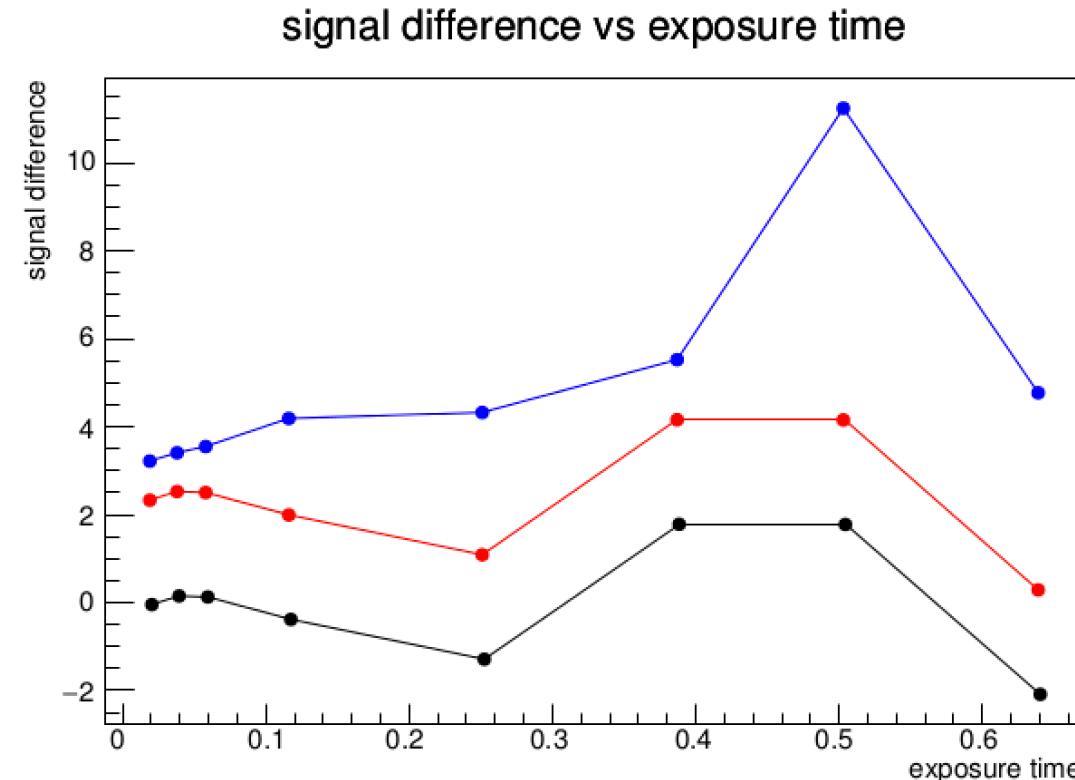
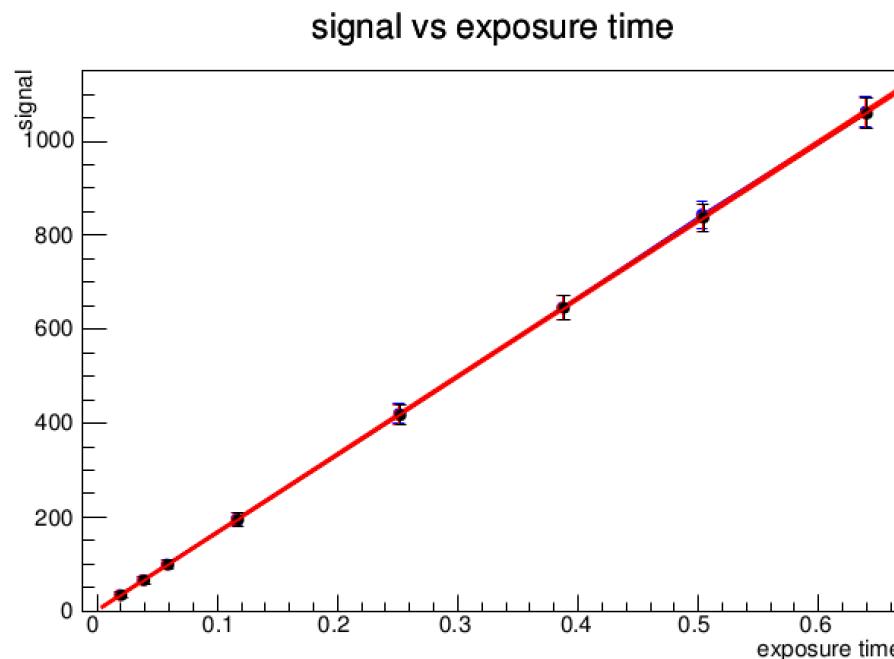
Before correction



After correction



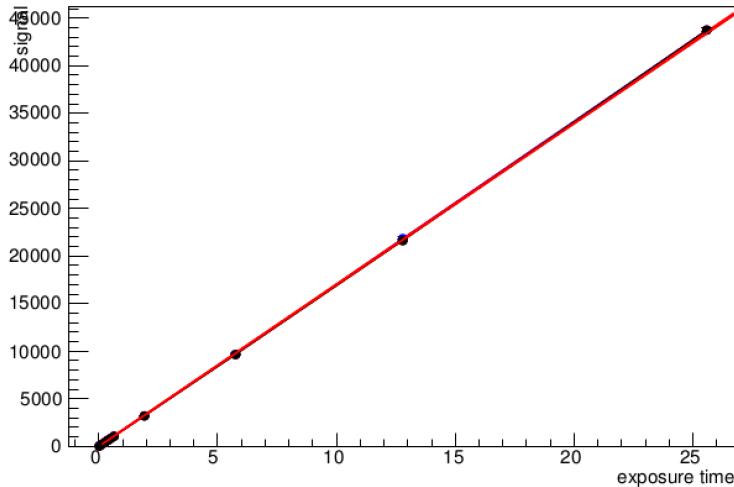
T_{exp} (0.019~0.639sec)



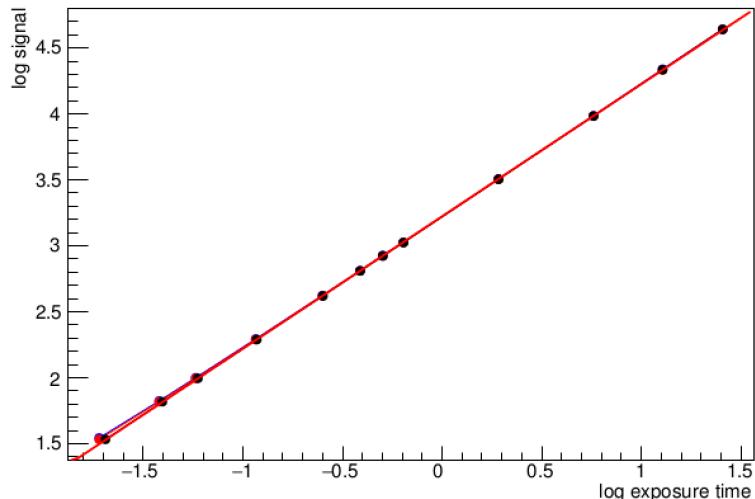
- Blue: signal vs T_{exp}
- Red: signal*1.418(*minimum mondiode*)/*mondiode* vs T_{exp}
- Black : signal*1.418/*mondiode* vs T_{exp} +shutter time

All T_{exp}

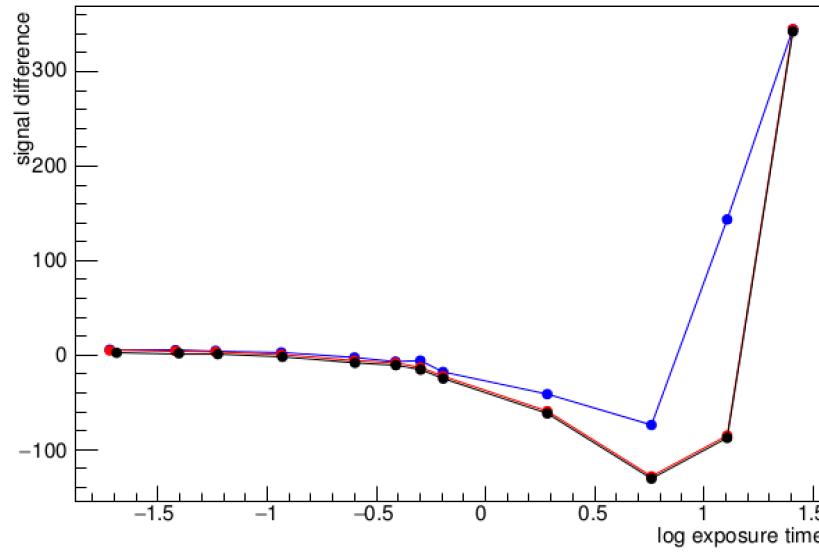
signal vs exposure time



log signal vs log exposure time

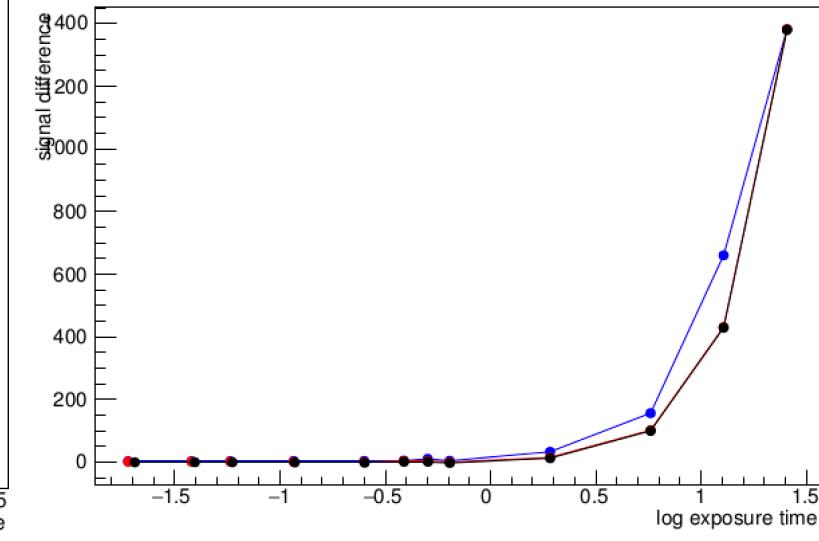


signal difference vs log exposure time



If I use the fit from short exposure times

signal difference vs log exposure time

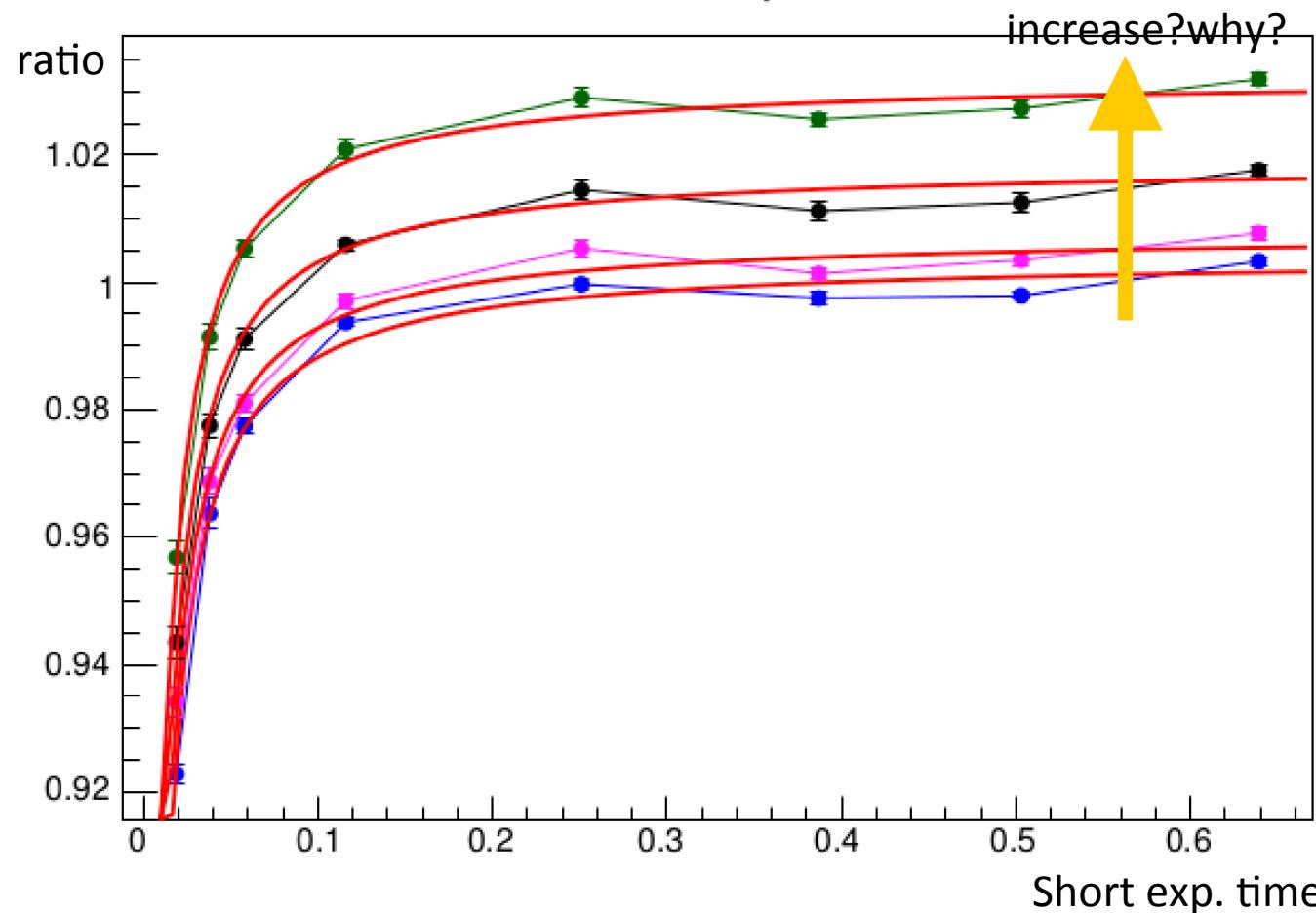


Question left

$$fit = \frac{1+p0/x}{1+p0/y} + p1$$

$p0=c$, $p1=\text{constant (offset) added to ratio}$

ratio vs short exposure time



25.581sec -Green

NAME	VALUE	ERROR
p0	1.56752e-03	4.92191e-05
p1	3.21821e-02	5.95395e-04

12.790sec -Black

NAME	VALUE	ERROR
p0	1.57431e-03	4.97835e-05
p1	1.85187e-02	6.17753e-04

5.755sec -Pink

NAME	VALUE	ERROR
p0	1.52308e-03	4.63221e-05
p1	7.56599e-03	5.47912e-04

1.918sec -Blue

NAME	VALUE	ERROR
p0	1.60659e-03	3.39675e-05
p1	3.22094e-03	3.34377e-04